

Nature and Properties of Waves

PS-7 The student will demonstrate an understanding of the nature and properties of mechanical and electromagnetic waves.

PS-7.5 Summarize the characteristics of the electromagnetic spectrum (including range of wavelengths, frequency, energy, and propagation without a medium).

Taxonomy Level: 2.4-B Understand Conceptual Knowledge

Key Concepts:

Electromagnetic spectrum

Visible spectrum

Propagation without a medium

Previous/Future knowledge: In the 8th grade students compared the wavelength and energy of waves in various parts of the electromagnetic spectrum (including visible light, infrared, and ultraviolet radiation) (8-6.8). Physical Science requires that students expand their concept of the nature of electromagnetic radiation. Students will summarize different types of radiation within the spectrum.

It is essential for students to understand

- That there is a wide range of frequencies and wavelengths of electromagnetic waves. The entire range of frequencies is called the *electromagnetic spectrum*.
- The relative positions of the different types of electromagnetic waves on the spectrum.
 - Students should know the order of electromagnetic waves from low frequency to high frequency: radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, violet), ultraviolet, X-rays, and gamma rays.
- Understand that the energy of electromagnetic waves is directly proportional to the frequency. When listed in order from lowest energy to highest energy, the list is the same as when listed from lowest frequency to highest.
 - Electromagnetic waves with higher frequencies than visible light also have more energy. This is why ultraviolet light can burn your skin, and X-rays and gamma can damage tissues.
 - Electromagnetic waves with lower frequencies than visible light and have less energy than visible light.
- Understand that the higher frequency electromagnetic waves have shorter wavelengths.
- Understand that wavelengths vary greatly from very long wavelengths (many meters) to very short wavelengths (the size of atomic nuclei).
- Understand that electromagnetic waves travel in space with no medium or may travel through a transparent medium.
 - All types of electromagnetic waves travel at the same speed in a vacuum.
 - Electromagnetic waves slow down when they move from a vacuum to a transparent medium.
 - Electromagnetic waves are transverse waves.

It is not essential for students to

- Explain the nature of the oscillating electric and magnetic fields in electromagnetic waves;
- Give the specific numbers for the wavelength or frequency range of different types of electromagnetic waves;
- Understand the concept of photons of energy, but this may be a good class discussion depending on the level of the students;
- Understand how different spectra (continuous, bright line/emission, dark line/absorption) are produced.

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Assessment Guidelines:

The objective of this indicator is to summarize the characteristics of the electromagnetic spectrum, therefore, the primary focus of assessment should be to give major points about the wavelengths, frequency, energy, and propagation without a medium for the different types of electromagnetic radiation.

In addition to *summarize*, assessments may require that students:

- Compare the frequency, wavelength, and energy of different types of electromagnetic radiation;
- Infer characteristics of a type of electromagnetic radiation from its position in the spectrum;
- Exemplify characteristics and types of electromagnetic radiation;
- Illustrate or use illustration to show characteristics of waves at different positions on the electromagnetic spectrum.